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The Spectrum Bogie

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# The Spectrum Bogie

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**HUDDERSFIELD**  
Institute of Railway Research

## Problem definition:

- ❑ The Spectrum train aimed to exploit the Low Density High Value (LDHV) goods market for containerised loads
- ❑ High speed (up to 160 km/h) was necessary to integrate with passenger services, with potentially lower axle load, fragile cargo, and an articulated wagon design
- ❑ An optimised running gear design was required

## Aim:

Produce a novel bogie concept with:

- High speed stability
- Safe running (compliant with Standards)
- Good ride quality
- High curving performance (low track damage)

## Process:

- ❑ Review of existing bogie designs and identify an appropriate base concept
- ❑ Determine initial values for suspension component parameters (lengths, stiffnesses, damping rates etc.)
- ❑ Construct a mathematical vehicle model (in Vampire) to optimise those parameters for the required performance
- ❑ Implement an iterative optimisation process with dynamic simulations to achieve the aims
- ❑ Produce a CAD model of the viable bogie concept

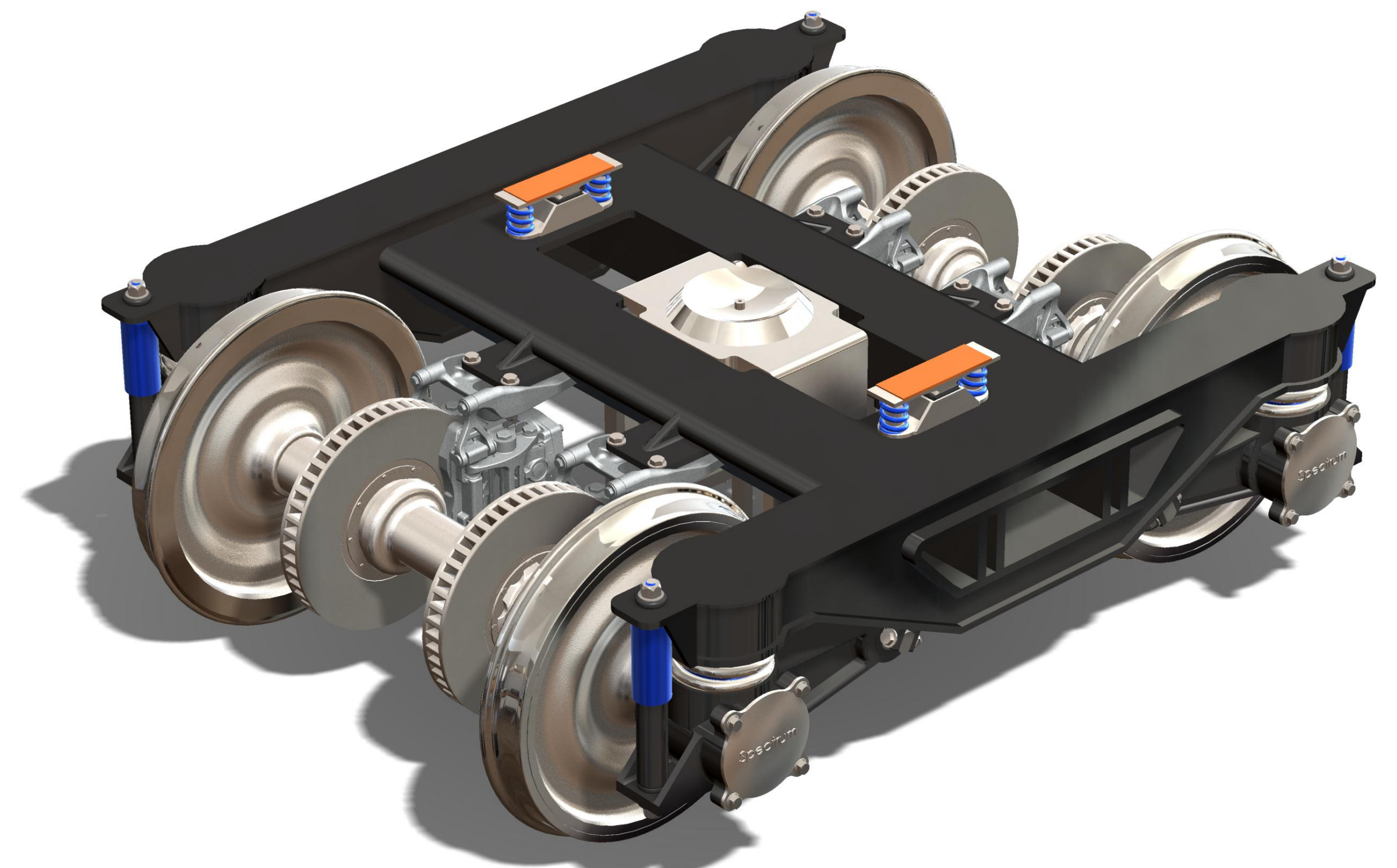
## Base Concept:

- ❑ A review of existing bogie designs led to a chosen base concept
  - Trailing arm primary suspension
  - Coil sprung
  - Viscous damped
- ❑ UIC secondary suspension
  - Standard centre bowl and side-bearer arrangement
- ❑ Axle mounted disc brakes
  - Required to operate alongside passenger stock
  - Dictated external axle boxes

## Initial Parameters:

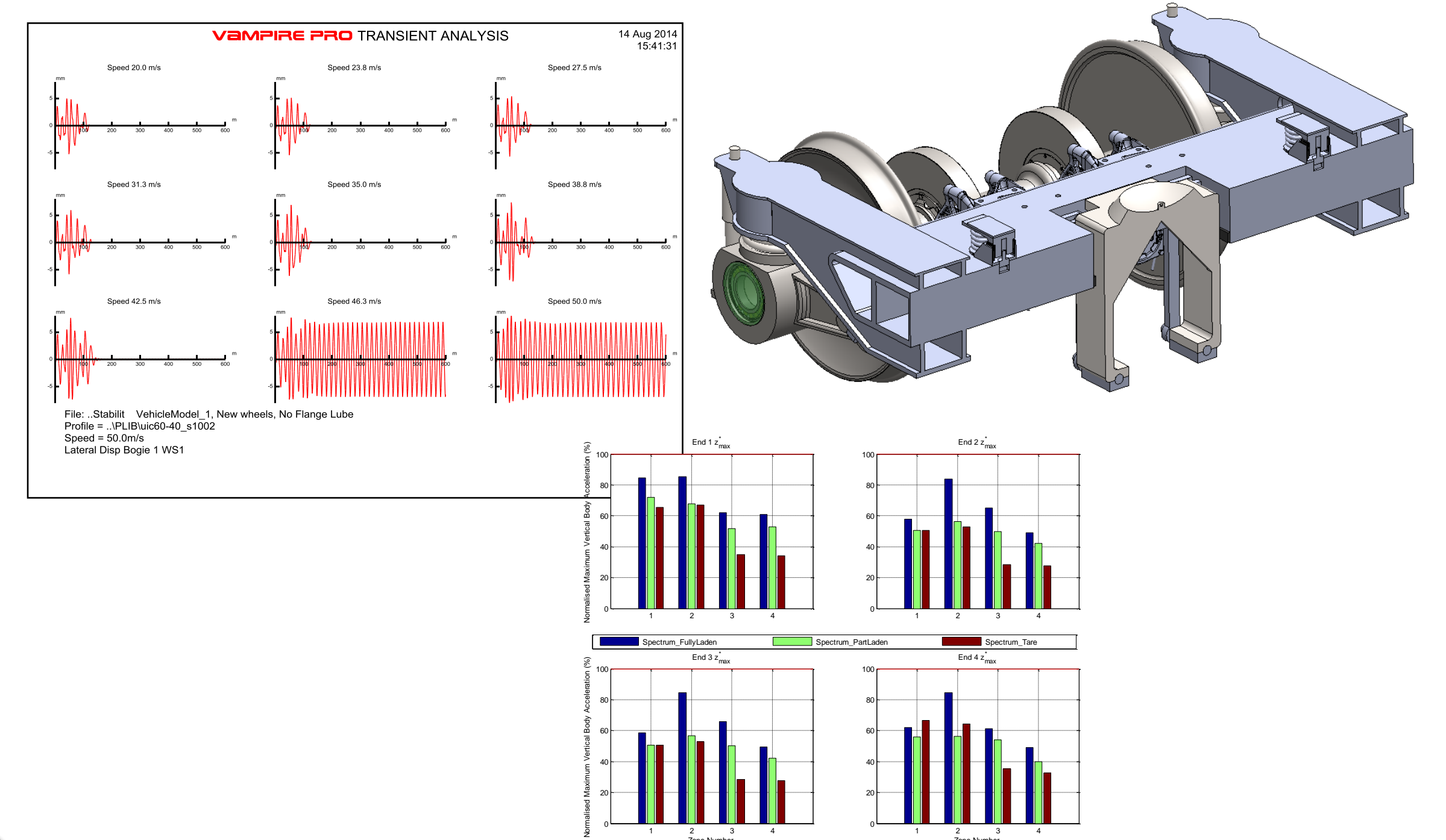
- ❑ Initial parameters can be determined a number of ways:
    - Calculation from fundamental principles  $\omega_n = \sqrt{\frac{k}{m}}$
    - Application of accepted vehicle design principles
    - Engineering judgement/application of experience
    - Derivation: for example the trailing arm bush parameters were determined by calculating their influence on primary yaw stiffness 'KY'
- $$KY_{TBY} = \frac{(Y_{TB}\theta)^2}{2} \cdot K_{TBY} \quad KY_{TBX} = Y_{TB}^2 \cdot K_{TBX}$$
- »  $K$  – Stiffness in given direction
  - »  $\theta$  – Wheelset yaw angle
  - »  $Y_{TB}$  – Trailing arm bush semi-spacing
  - »  $TB(X,Y)$  – Trailing arm bush longitudinal and lateral directions

## Final Bogie Design:



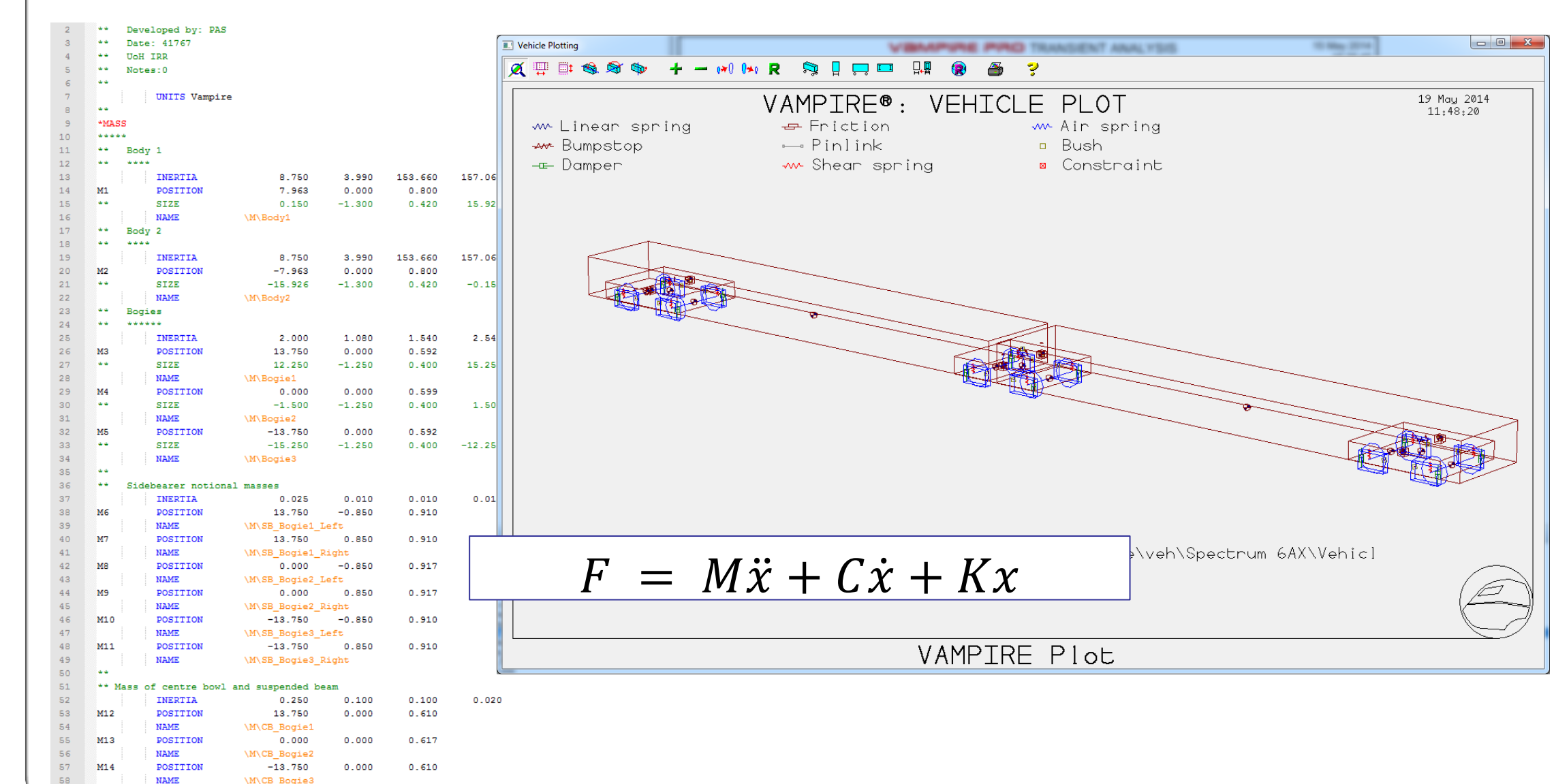
## Analysis and optimisation:

- ❑ The vehicle parameters were used to create a Vampire multi-body dynamics model



## Mathematical Vehicle Model:

- ❑ The vehicle parameters were used to create a Vampire multi-body dynamics model



## What was achieved?

- ❑ A novel bogie concept was developed - featuring conventional/proven suspension components and technologies, but in a novel arrangement and application. Swing links were introduced to the UIC secondary suspension to improve lateral ride and stability.
- ❑ Improved dynamic performance with reductions of between 8% and 16% in Variable Usage Charge compared to a conventional Y-series container vehicle (calculated with Network Rail's Variable Track Access Charge)

Inspiring tomorrow's professionals

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